Science Questions

Q1 What are the effects of land on nearshore Arctic biogeochemistry?

- How do freshwater carbon, nutrient, and sediment fluxes to the coastal zone change as a results of:
  - changing riverine and groundwater inputs,
  - passage through estuaries and gradients,
  - and coastal erosion and thawing permafrost?
- How do these changing fluxes affect nearshore Arctic biogeochemical and ecological processes?
- How has the relative magnitude of inputs from rivers and coastal erosion changed across the nearshore Arctic seasonally and interannually?

Q2 What are the effects of ice on nearshore Arctic biogeochemistry?

- How does flow alteration/channeling by morphological ice conditions impact terrestrial fluxes into and attenuation within, the nearshore Arctic?
- How does the coastal snow/ice cover impact nearshore Arctic biogeochemical processes by controlling rates of mixing and by modulating light availability?
- How does the timing of sea ice formation/retreat, duration of sea ice cover and ablation, snow accumulation, and the morphology of the coastal ice zone influence nearshore Arctic biogeochemical and ecological processes?

Q3 What will be the effects of future change (warming land and melting ice) on nearshore Arctic biogeochemistry?

- On seasonal to interannual time scales, how will changing land (Question 1) and melting ice (Question 2) impact nearshore Arctic biogeochemical and ecological processes?
- On interdecadal time scales, how will changing land (Question 1) and melting ice (Question 2) impact nearshore Arctic biogeochemical and ecological processes?

Approach

Map to Science

Approach	Map to Science
A Use a rich synthesized dataset of existing field and satellite datasets (Phase I) (i) for initial RS algorithm and model development and (ii) to optimize the design of field studies and deployments	Q1, Q2, Q3
B Conduct new field observations and process studies/quantitative experiments across intensive study sites (Tier 1 and 2) and synoptic surveys (Tier 3 sites) (Phase II), to: (i) assess current conditions in the coastal Arctic, (ii) develop improved coupled hydrodynamic-bio-geochemical model parameterizations, and (iii) develop new RS algorithms and ocean color products	Q1, Q2, Q3
C Extend ship and boat based measurements over different seasons and multiple years using buoys, moorings and autonomous platforms, to assess seasonality and capture year-to-year variability in Arctic processes	Q1, Q2
D Link in-situ observations to remotely sensed quantities, for quantitative assessments of land-ice-ocean interactions from RS (space and suborbital) assets, and use RS in hindcast mode to distinguish between climate change trends and shorter term variability	Q1, Q2
E Use in-situ and RS datasets to develop new coupled hydrodynamic-ecological models for assessing impacts of future change on nearshore Arctic biogeochemistry.	Q3
F Integrate measurements and model results during a 2-year Synthesis Phase (Phase III)	Q1, Q2, Q3

Measurements and modeling

Map to Science & approach

FIELD OBSERVATIONS (Approach: B, C, D, E, F)

Measurement	Map to Science
Geomorphology and land-ocean fluxes characterization: freshwater discharge/volume transport (river, groundwater, surface runoff, coastal erosion fluxes, bathymetry	Q1, Q3
Ice/snow characterization: land fast and ice properties (thickness, temperature, area extent)	Q2, Q3
Water column characterization: water column physicochemical properties, sediment properties, circulation, hyperspectral UV-VIS-NIR optics, lidar-based profiling of optical properties.	Q1, Q2, Q3
Biogeochemical/ecological processes: biogeochemical stocks and fluxes, transformation rates, primary production, assimilation/grazing, community respiration, aggregation/flocculation, photochemical and bacterial transformation of organic matter, plankton community structure, algal bloom development, development of hypoxia, acidification.	Q1, Q2, Q3
Meteorological/atmospheric measurements: clouds, precipitation, humidity, winds, temperature, aerosols, trace gases.	Q1, Q2, Q3

- A set of core measurements (Table 8.2) will be conducted across all sites), while non-core measurements will be conducted only at selected (Tier 1 and 2) sites

REMOTE SENSING (Approach: A, B, D, E, F)

Measurement	Map to Science
Active and passive (moderate-high resolution UV-VIS-NIR) RS retrievals of ocean optical (e.g., Rrs, a, bb) biogeochemical (e.g., Chla, DOC) and physical (SST, wind, current vectors) properties; active and passive RS of atmospheric composition (for improved OC atmospheric correction)	Q1, Q2
RS of land characteristics (e.g., permafrost cover, vegetation cover, fire frequency in river basins) in collaboration with ABoVE	Q1
RS determination of coastal ice and snow cover	Q2

MODELING (Approach: A, B, C, E, F)

Measurement	Map to Science
Linked coupled hydrodynamic-photochemical biogeochemical ocean models to land processes (e.g., permafrost dynamics, watershed processes)	Q1
Link coupled coastal ocean biogeochemical models to sea ice models	Q2
Link land-sea-ice models to ecosystem-based models	Q1, Q2
Climate modeling	Q3

Requirements

Deployments

- Minimum requirements: 2-year measurements program (shipboard, ground-based and airborne platforms) at Tier 1 sites (2 complete annual cycles) and synoptic survey (one annual cycle), to assess seasonal and inter-annual variability.
- Optimum deployment: 2-year field observations at Tier 1 and Tier 2 sites, and synoptic survey (Tier 3 sites), extending the temporal domain of the campaign to 4 years

Platforms

- 6-35 m length landing crafts and small RVs for in-shore and river work.
- 35-80m length coastal research vessels (RVs) with standard hydrographic equipment for coastal work (includes R/V Sikuliaq for light ice-breaking capability)
- Medium-to-large (75-130m length) ice reinforced RVs primarily for deeper shelf waters and during thick ice conditions.
- Buoys, moorings, and gliders
- Land towers for optical and atmospheric instrumentation.
- Small planes/UAV, helicopters, with seasonal deployments over study region
- Over-the-snow/all-terrain vehicles

Integration

- Integration of existing datasets and modeling tools into the project (Phase I)
- Integration across all disciplines, observational approaches and modeling efforts (Phase III)
- Integration with current and future campaigns in the Arctic (Phase I-III)
- Use modeling and remote sensing to scale up fluxes and processes in both temporal and spatial domains

Coordination/partnerships

- Collaboration with other federal and state agencies and regional and private programs
- Engagement of local communities throughout the life cycle of the project
- Leverage existing infrastructure (e.g., ABoVE)
- Partnerships with ongoing U.S. and international efforts in the Arctic (e.g., Polar Knowledge Canada, ArcticNET, and Sentinel North).
- Coordination with other programs addressing climate change and the human dimension in the Arctic.
- Open meetings to engage the community and encourage partnerships